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# U.S. PATENT APPLICATION

# for

# DUCT FAN

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## CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

**[0001]** Federal Republic of Germany Priority Application 103 13 991.5, filed March 27, 2003 including the specification, drawings, claims and abstract, is incorporated herein by reference in its entirety.

## BACKGROUND OF THE INVENTION

**[0002]** The present invention relates to a duct fan having a distributor that has a plurality of vanes.

**[0003]** DE 26 07 984 A1 discloses a duct fan having an axial impeller that is driven coaxially in the duct that is to be ventilated, by a low-power electric motor arranged within the cylindrical or frustoconical impeller hub. Radial supporting crosspieces are provided, and these serve as the fastening framework of which the external diameter is spaced apart only slightly from the inner wall of the duct for a snug fit. In this case, the fastening framework is designed as a single-piece plastic injection molding. Such a duct fan, however, still leaves something to be desired.

## SUMMARY OF THE INVENTION

**[0004]** One object of the invention is to provide an improved duct fan.

**[0005]** In accomplishing the objects of the invention, there has been provided according to one aspect of the invention a duct fan adapted to be arranged in a duct, comprising a motor, an impeller adapted to be driven by the motor, and a distributor having a plurality of vanes which are adapted to contact the duct and form a connection between the duct and the motor.

**[0006]** Further objects, features and advantages of the present invention will become apparent from the detailed description of preferred embodiments that follows, when considered together with the accompanying figures of drawing.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** In the drawings:

**[0008]** Figure 1 is a cut-away view of a first exemplary embodiment,

**[0009]** Figure 2 is a view, in detail form, of the electrical contact-connector,

**[0010]** Figure 3 is a cross-sectional view taken transversely to the longitudinal axis in order to illustrate the cable guidance,

**[0011]** Figure 4 is a cross-sectional view taken transversely to the longitudinal axis for a second exemplary embodiment, and

**[0012]** Figure 5 is a side view of a distributor with integrated drive.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0013]** According to the invention the fastening function is integrated into the vanes of a distributor. The invention provides a duct fan having a distributor that has a plurality of vanes. The vanes of the distributor are connected to the duct at the outer end. This means that there is no need for any additional struts, for fastening and stabilizing purposes, which would adversely affect the air flow.

**[0014]** It is preferable for the vanes to be distributed around the circumference of a base body of the distributor; however not all the vanes necessarily serve for fastening purposes. It is possible for the vanes to be arranged at equidistant spacings from one another or to be distributed in some other way around the circumference. It is also possible, in particular, for the vanes to be configured with different thicknesses in order to accommodate, for example, an air supply for separate air cooling.

**[0015]** The distributor may be fixed, for example, to a housing of the motor, in which case a shaft of the motor is then advantageously fixed to the impeller. Conversely, it is also conceivable for the impeller to be fastened on the motor housing, in which case a motor shaft is then preferably fastened on the distributor.

**[0016]** According to a preferred embodiment, the bases of the vanes are connected to the base body of the distributor. The base body of the distributor serves as a mount (motor holder) for an electric drive, for example, for a brush motor. In a preferred construction, the entire distributor (base body + vanes) is designed as a complete drive

(as a unit), it being possible to integrate all common types of motors (brush motor, brushless motor, reluctance motor, etc). The basic body of the distributor thus forms the cylindrical base body of the electric motor. The duct fan is then designed as an entire system, which vastly simplifies final assembly.

**[0017]** It is preferable for at least one vane to be designed as a cooling device. Provision is made in this regard for thermal contact connection between the vane, if appropriate, the base body of the distributor, and the electric motor, thereby resulting in good thermal conduction from the electric motor to the outside. It is also possible for electronic components which are arranged, for example, in the interior of the base body to be cooled in this way. If all the vanes are of corresponding design, this still gives rise, on account of the relatively large surface area of the vanes, to a sufficiently good cooling effect at high air temperatures, despite a relatively small temperature difference. For this purpose, the vanes and/or the base body are/is produced, particularly wholly or partially, from metal, preferably aluminum.

**[0018]** One preferred embodiment provides separate air cooling from the outside. Air-supply, and possibly also air-discharge, ducts are arranged in one or more vanes in this embodiment. An impeller for the separate air cooling is preferably arranged in the interior of the distributor, this impeller being connected, for example, directly to the output shaft of the electric motor, on which the impeller is likewise preferably fitted. In this case, it is possible, despite the high temperatures, for individual air-channeling vanes, or all of these vanes, to be produced from plastic. In another preferred embodiment, the air from the separate air-cooling means flows out into the duct without an impeller.

**[0019]** The power supply of the electric motor is preferably provided through at least one of the vanes. It is possible, for this purpose, for one or more vanes to be provided with one or more cable ducts and/or through-openings through which cables are guided. It is particularly preferred for the normal power supply of the electric motor and for the control current (for electronics) to be spatially separated, thus reducing the susceptibility to malfunctioning. Avoiding the hitherto free feeding of cables improves the channeling of air, since there are no aerodynamic resistances present, and the noise level is thus also reduced.

**[0020]** According to an alternative embodiment, instead of a cable, the power-conduction means is formed by one or more externally insulated, electrically conductive elements which form the core of at least one vane. These elements are preferably bent sheet-metal parts.

**[0021]** An electrical contact-connection means is preferably provided at the radially outer end of the vane. This may be, in particular, a plug socket, but also a plug, as a result of which straightforward and quick contact and connection is possible following installation.

**[0022]** The power and control electronics are preferably arranged in the inner region of the distributor, in particular at locations which are particularly well cooled.

**[0023]** It is preferable for at least two vanes, in particular widely spaced-apart vanes, to be provided, at their outer end, with mounts and/or internal threads. Pins, screws or other fastening means are introduced into the latter for the purpose of fastening the duct fan, these fastening means ensuring a secure connection between the duct and impeller. This simplifies assembly and thus reduces the production costs. In a preferred construction, it is also possible to arrange isolating elements, for noise-reduction purposes, between the vanes and the duct.

**[0024]** For this purpose, it is preferable to provide, on three approximately equally spaced-apart vanes, bores with internal threads, which are aligned with bores in the duct and into which screws are inserted. As an alternative, it is possible for just two vanes to be fixed to the duct by means of various fastening elements, and a housing of an integrated plug being configured such that the latter, in addition, forms the third fastening point. Fixing at the third fastening point is preferably configured such that assembly can be realized with very low outlay, such as, in a preferred configuration, by a plug-in connection with a close fit.

**[0025]** Connection of the vanes of the duct fan to the duct is simplified, according to one advantageous configuration, in that the duct has a shoulder which serves as a stop for the vanes. In another embodiment, the vanes may be connected by an outer ring, in which case the outer ring is then connected to the duct. In a further embodiment, the vanes may have, at their ends, thickened portions which can be plugged, for example, into grooves in the duct.

**[0026]** In all the types of connection described, it is possible for isolating elements, e.g., made of elastomeric material, to be positioned between the duct fan and duct.

**[0027]** Turning now to the drawings, a duct fan 2 according to the invention, which is arranged coaxially in a duct 1, comprises an impeller 3 with its impeller hub 4, an electric motor 5, in the exemplary embodiment a brush motor, and a distributor 6 with vanes 7. The impeller 3 is driven by the electric motor 5, which is arranged in the distributor 6. In addition to performing the function of directing air, the vanes 7, also simultaneously serve as supporting struts and for fastening on the duct 1. For the latter purpose, according to the present exemplary embodiment, two screws project from the outside through corresponding bores in the duct 1 and are screwed into threaded bores provided in two of the vanes 7. The third fastening point is formed by the connector plug housing 9. Further additional functions of the vanes 7 will be described later in the text.

**[0028]** Provided for supplying the electric motor with power is a cable 8, which extends from the electric motor 5 and is guided outwardly through one of the vanes 7 that forms a cable duct, i.e. the electrical supply lead is integrated. The cable 8 terminates in a plug housing 9, which can be contact-connected from outside the duct 1 (see Figures 2 and 3).

**[0029]** The duct fan 2 is operated at high air temperatures, for example of 125°C, as a result of which conventional duct fans are beset by cooling problems in relation to the electric motor 5. According to the first exemplary embodiment, heat is discharged from the electric motor 5, which is arranged in the impeller hub 4, via the base body of the distributor 6, to the vanes 7. The vanes are designed as a cooling device, have a comparatively large surface area and are exposed to the air flowing past, which in the present embodiment flows first past the impeller 3 and then past the vanes 7, with the result that optimum discharge of heat can take place. For this reason, even a relatively small temperature difference between the air temperature and electric-motor temperature is sufficient for cooling the electric motor 5. By virtue of heat being discharged outwardly, it is also the case that other components, for example transistors, which are part of power and/or control electronics 10 are protected against overheating.

**[0030]** A second exemplary embodiment essentially corresponds to the first exemplary embodiment, and in this case the same or equivalent elements are provided with designations that are higher by 100 than in the first exemplary embodiment. In the second exemplary embodiment, the cooling device, which is formed by the vanes 107, is accompanied by a second cooling device, which supplies cooler air to the electric motor 105 from outside the duct. For this purpose, two vanes 107 are provided with air ducts 120, of which one serves for supplying air and one serves for discharging air. The airflow is indicated schematically by arrows in Figure 4. Provided in the interior of the distributor 106 is a cooling impeller 121 which is driven by the same electric motor 105 as drives the previously described impeller. The cooler air supplied from the outside cools not just the electric motor 105, but also the power and control electronics thereof.

**[0031]** Corresponding to the first exemplary embodiment, the power supply of the electric motor 105 is preferably provided via a cable (not illustrated) which is guided through one of the vanes 107. The control current is typically supplied separately, via a further, correspondingly designed arrangement.

**[0032]** One of the three fastening devices 114 (e.g., threaded bore) is indicated schematically on the central vane 107 in Figure 5, as well as a resilient isolating element 112.

**[0033]** The foregoing description of preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible and/or would be apparent in light of the above teachings or may be acquired from practice of the invention. The embodiments were chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined the claims appended hereto and that the claims encompass the disclosed embodiments and their equivalents.